MAIN BENEFITS AND LIMITATIONS OF USING CONVENTIONAL ROUNDABOUTS AND TURBO-ROUNDABOUTS ALONG CORRIDORS

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The implementation of roundabouts may result in a trade-off among capacity, environmental, and safety variables. Also, little is known about the benefits and limitations for traffic and vulnerable users from the use of functionally interdependent roundabouts in series along corridors.

Thus, this doctoral thesis stressed the importance of understanding in how roundabout corridors affect traffic performance, vehicular emissions and safety for vulnerable users as pedestrians. The development of a methodology capable of integrating corridor's characteristics was a major contribution of this work. The specific objectives of the thesis were: 1) to analyze the effect of corridor's design features in the acceleration patterns and emissions; 2) to understand the differences in the spatial distribution of emissions between roundabouts in isolation and along corridors; 3) to compare corridors with conventional two-lane roundabouts and innovative design solutions, as is the case of turbo-roundabouts; and 4) to design corridor-specific characteristics to optimize vehicle delay, and carbon dioxide (CO_2), carbon monoxide (CO), nitrogen oxides (NO_X) and hydrocarbons (HC) emissions.

Vehicle dynamics along with traffic and pedestrian flow data were collected from 12 corridors with conventional roundabouts located in Portugal, Spain and in the United States and 3 turbo-roundabout corridors in the Netherlands. Data for approximately 2,000 km of road coverage were collected. Next, a microscopic platform of traffic (VISSIM), emissions (Vehicle Specific Power – VSP) and safety (Surrogate Safety Assessment Model – SSAM) was introduced to faithful reproduce site-specific operations and to examine different alternative scenarios.

The main research findings showed that the spacing between intersections influenced vehicles acceleration-deceleration patterns and emissions along corridors with conventional roundabouts and turbo-roundabout. In contrast, the deflection angle at the entrances (element that impacts emissions on isolated roundabouts) impacted slightly on the spatial distribution of emissions. It was also found that the optimal crosswalk locations along mid-block sections in roundabout corridor was generally controlled by spacing, especially in the case of short spacing between intersections (<200m). The implementation of turbo-roundabout corridors increased emissions compared to

conventional two-lane roundabout corridors (1-5%, depending on the pollutant). However, the differences between layouts were not statistically significant (p-value < 0.05). By changing the location of a turbo-roundabout (from 180 to 240 m) to increase spacing in relation to upstream/downstream intersection resulted in an improvement of corridor emissions (4-11%, depending on the pollutant).

This thesis contributed to the current state-of-art by proving a full comprehension about the operational and geometric benefits and limitations of roundabout corridors. Also, it established correlations between geometric variable of corridors (spacing), crosswalk locations or traffic streams, and delay, and CO_2, CO, NO_X or HC variables. Therefore, the develop methodology is a decision supporting tool capable of assessing and selecting suitable traffic controls according the site-specific concerns.

KEYWORDS: Corridor, emissions, modelling, roundabouts, turbo-roundabouts, safety.

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